

EDGERTON, GERMESHAUSEN & GRIER, INC.

FIREBALL CALCULATIONS
SHOT HUMBOLDT
OPERATION HARDTACK PHASE II
PROJECT 15.1

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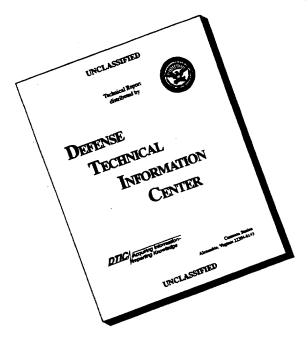
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DISTRIBUTION STATEMENT A APPLIES PER NTPR REVIEW.

What 2 have DATE 4/25/96

REPORT NO. B-2063 4 MARCH 1960 BOSTON, MASSACHUSETTS • LAS VEGAS, NEVADA
SANTA BARBARA, CALIFORNIA

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Defense Nuclear Agency 6801 Telegraph Road Alexandria, Virginia 22310-3398



ISST

29 May 1996

MEMORANDUM FOR DEFENSE TECHNICAL INFORMATION CENTER ATTENTION: OCD/MR. BILL BUSH

SUBJECT: Documents for DTIC System

There is no record of your office receiving the following reports:

EGG-B-2064 (4 March 1960) Fireball Calculations Shot Wrangell Operation Hardtack Phase II, Project 15.1

EGG-B-2063 (4 March 1960) Fireball Calculations Shot Humboldt Operation Hardtack Phase II Project 15.1

Both documents are now approved for public release.

Therefore, we are transmitting copies for inclusion into the DTIC system, if not found there.

Enclosure:

A/S

Andith Jamets
ARDITH JARRETT

Chief, Technical Support

FIREBALL CALCULATIONS

SHOT HUMBOLDT

OPERATION HARDTACK, PHASE II

PROJECT 15.1

Report No. B-2063 4 March 1960

Approved by

EDGERTON, GERMESHAUSEN & GRIER, INC.

Boston, Mass.

Santa Barbara, Calif.

Las Vegas, Nev.

FIREBALL CALCULATIONS - SHOT HUMBOLDT

1.0 INTRODUCTION

Shot Humboldt was a thirty-foot tower shot sponsored by LRL and detonated on 29 October 1958 in Area T-3V of the Nevada Test Site at 0645 FST.

The fireball yield was 3.3 tons + 0.3 ton.

2.0 CAMERA INSTRUMENTATION AND OPERATION

Photographic coverage of fireball growth was provided by four high-speed Eastman cameras, two each at Station 3-357 (Transportainer No. 3) and Station 3-358 (White Truck No. 2). Two Rapatronic cameras were located at each of these stations to record early fireball growth. In addition, a 15,000 frame-per-second EG&G Framing camera was used, located at Station 3-358 (6 x 6 No. 1). All cameras produced good records of this low-yield tower shot.

Station locations together with burst location are shown in Figure 1. Figure 2 is a summary of the survey data.

3.0 RESULTS

Application of phi-comparison (EG&G Report No. B-1869) indicates a yield of 3. 3 tons + 0.3 ton for Shot Humboldt.

An air density of 1.097 grams per liter was used in the yield calculations, based on a pressure of 885 millibars, a temperature of 7.4°C, and a relative humidity of 46% at the height of the device at shot time.

The following table shows the comparison shots and the Humboldt yield obtained by the phi-comparison.

	Humboldt Yield (Tons)
Comparison Shot	Humbold III
Air Drop	
Osage Ranger A Buster B Wasp Wasp [†] Ranger E	3.35 3.17 3.20 3.41 3.41 3.25
Balloon	
Rushmore Hidalgo Lea	3.51 3.36 3.46
Tower	•
Post UK-3 Chaves Hornet Moth Quay	3. 26 3. 25 3. 53 3. 33 3. 19 3. 24
	$\overline{W} = 3.3 \text{ tons}$

Diameter vs time and phi vs time plots are shown in Figs. 3 and 4.

The following data sheets are included for each film:

- a) Photo Plan and Photo Loading Chart
- b) Camera Data and Calculation Sheet
- c) Diameter Measurement Sheet
- d) E-102 Print-Out Sheet of D, t, and \emptyset

The zero-frame times of the Eastman and Framing camera records were determined by comparison with the Rapatronic diameter-time data.

Appendix A contains photographic examples of the Humboldt fireball.

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SURVEY

HUMBOL OT

DATA

DATE 10/29/58

62 STA. 73V

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STEET S FEER CO. MADE IN U.S.A

Table I

Hardtack Phase II, Humboldt
Fireball Camera Distribution

Station	Camera	Qualitative Functioning
3-357	E-33	Record
Transportainer No. 3	E-1	Record
	R-34	Record
	R-30	Record
3-358	E-11	Record
White Truck No. 2	E-5	Record
WIII - 11 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1	XR-3	Record
	R-4	Record
3-358	Framing	Record
6 x 6 No. 1		

Table II

Hardtack Phase II, Humboldt
Average Diameter vs Time

Time (m sec)	Diameter (meters)
0. 5	10.5
1.0	13.5
1.5	15.5
2. 0	17.0
2.5	18. 5
3.0	19. 5
3, 5	20.0
4.0	21.0

Table III

Hardtack Phase II, Humboldt

Rapatronic Summary

Station	Film No.	Camera No.	Horizontal Range (m)	F. L. (mm)	Diameter (m)	Time (ms)
3-357	60851 60852	R-34 R-30	2339. 3 2339. 3	479. 03 479. 30	13. 67 3. 75	0,99
3-358	60794 60795	XR-3 R-4	2163.9 2163.9	476,76 477.82	5, 21.	0.10

REMARKS EDGENTON, GERMENAUSEN & GERER. EVENT HUMBOLDT FINAL 10/29/50 GZ STA. 73 V DATE POSTED PUR-15.1 FICK. BRG 21017 TILT 0°/3' 0°28 DELAY Ŋ OBJ. S/X 25 MARKER TYPE 200 PLAN 2577 57 VOLTS RHEO. ON/OFF DIFF. 8/99 1-1 POWER 115 AC MAX 24 CC 010Ha 054* 984 378 29 0°00' 0°29' > 836 687 A AIMING I OBJECT F.B R 830 366 E 684 801 Z 3 997 REMARKS * INCLUDES 30 ft, height of Tower STATION FIELD **₹** FILTER NO.5 W-12 ££ LENS SISTANCE OBJECT 7/02.3 Z/S DISTANCE GZ 7102.0 FF TATION TYPE 6x6 # TATION NO. 3-358 10 in. MA MA NOM RACK SPD. POS. CAMERA 16,000 A OFF WAS 10∰ Š. FR

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STA	STATION 3-358		6x6 #		EVE	N.	EVENT HUMBOLDT	120T			_ DAT	DATE 10/29/58	9/58
		M I			3	CAMERA]	LENS	لت	EXPOSURE	₹	
13 PE	EMULS. NO.	SIZE	HOLDER	PERF.	Ŏ.	RACK POS.	NON SPO COS	Foc. Foc.	FILTER	APER	SHUTTER W/M2	W/M2	KEMAKKS
ME		35×11	CASSETTE	60,872	Z# 27	-	16,000	10 in.	ND.5 W-12	£9.0	MAX	1x105	
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												•	FINAL
TOR.	E-40									<u> </u>	EDGERTON,	GERMESHAUSEN	IAUSEN B GRIER,

TATION NO. 3-358

TATION TYPE WHITE TRUCK NO 2 STATION

ISTANCE GZ 7099.4 FF

N 830 358 E 684 829 Z 3 997 STANCE OBJECT 7/00.0 ft

PHOTO PLAN

4054* **G Z** 836 984 687 378

DIFF. 6626

0810°28′ Tur GZ O L 2549

EVENT HUMBOLDT BRG 21,03

GZ STA. 73 V

10/29/58 DATE POSTED

NOW BACK FOC. S/N FILTER LABORT HAND NO. 15 SHU. TIME TOWNOR FILTER TABORT FOR THE SIN AS AS TABORT FOR THE SIN AS <th< th=""><th>J</th><th>CAMERA</th><th>4</th><th></th><th>LENS</th><th></th><th>FIRD</th><th>A</th><th>AIMING</th><th>\ \ \</th><th>:</th><th>POWER</th><th>æ</th><th>MARKER</th><th>KER</th><th>> 000</th><th>7</th><th>Ę</th><th>DEMABYC</th></th<>	J	CAMERA	4		LENS		FIRD	A	AIMING	\ \ \	:	POWER	æ	MARKER	KER	> 000	7	Ę	DEMABYC
2500 C-7 305 784691 W-2270 F.B 0°00 °229 '200 K °80 -74.5 200 60 = MF 15.1 2500 C-2 254 876312 W-12 .745 F.B 0°00 °245 '1200 R °80 -74.5 200 10 = MF 15.1 44.1 480 774695 ND-1 .740 F.B 0°00 °246 '2400 80.8 = FM 5 100 RP 15.1 5012 A-1 480 774695 ND-1 .740 F.B 0°00 °246 '2400 80.8 = FM 5 100 RP 15.1 64 C-3 1/8.5 1/026 = 4.50 DOC. 0°00 829 '2400 133° -5/430 = E 200 RP 15.1 64 C-3 1/8.5 1/2297 = 4.50 DOC. 0°00 829 '2400 133° -5/430 = E 200 RP 15.1 64 C-3 1/8.5 1/2297 = 4.50 DOC. 0°00 829 '2400 133° -5/430 = E 200 RP 15.1 65 C-3 1/8.5 1/2297 = 4.50 DOC. 0°00 829 '2400 133° -5/430 = E 200 RP 15.1 65 C-3 1/8.5 1/2297 = 4.50 DOC. 0°00 829 '2400 133° -5/430 = E 200 RP 15.1 65 C-3 1/8.5 1/2297 = 4.50 DOC. 0°00 829 '2400 133° -5/430 = E 200 RP 15.1 66 C-3 1/8.5 1/2297 = 4.50 DOC. 0°00 829 '2400 133° -5/430 = E 200 RP 15.1 67 C-3 1/8 1/8 1/8 1/8 1/8 1/8 1/8 1/8 1/8 1/8	S O	NOM SPD.	RACK POS.	A CC	s/N	_	TARGET H/V	OBJECT	x		VOLTS	HEO.	TIME ON/OFF	TYPE	N/S	15	§	POSE	CANADA
$ 2500 \ \ C-2 \ \ \ \ \ \ \ \ \ \ \ \ \ $				305	784691	NO-1 W-12	.270	1	0.00,	+0°29′	20 DC 4		-1.5/ /+1.5	200	90		MF	(5.1	
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	5-5	2500	C-2	254	876312		.250		0,00,0	+ 5*5'	2000		1.5	200	0/	. 11	ME	15.1	-
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	x.R-3	4x5 CO12	1-1		774695	ND-1	.740	B	0,00,	7,9%	1/5 AC 24 DC E	3018		FM	ک	001	RP	15.1	100 usec delay
64 C^{2} /8.5 //026 = $\frac{4.50}{2.590}$ Doc. 0°00'8'29' 24.0c /33° $-5/430$ = = = $\frac{2}{2.590}$ 64 C^{3} /8.5 //2297 = $\frac{4.50}{2.590}$ Doc. 0°00'8'30' 24.0c /33° $-5/430$ = = = $\frac{2}{2.590}$ 65 C^{3} /8.5 //2297 = $\frac{4.50}{2.590}$ Doc. 0°00'8'30' 24.0c /33° $-5/430$ = = = $\frac{2}{2.50}$ 65 C^{3} /8.5 //2297 = $\frac{2.590}{2.590}$ Doc. 0°00'8'30' 24.0c /33° $-5/430$ = = = $\frac{2}{2.50}$	4-8	40µs C01L	A-2	480	773952	b	.740	FB.			115 AC 22 BC 6	BULB		FM	ک	3000	RP		3000 usec delay
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ACTUAL RAP DELAYS XR-3 97.4 y sec - 2, sec - 20, sec -											مه مصدرين		-						
ACTUAL RAP DELAYS XR-3 974 prec 2 sec.											.3. *								
ACTUAL RAP DELAYS XR-3 97.4 µsec + 2µsec R-4 3127.6 µsec + 20µsec																			
XR-3 97,4 wrec - 2,5ec.							ACTU			_	رج								
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	The second second						R-4	3/27		دود ع	20%		ialf co		ry.				

REMARKS TINCS

FINDL

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	LENS	FILTER	NO-1 + W-12	W-/2	1-0N	}}	ĵ	11		,			+2 x50	-20 M Sec				
EVENT HUMBOLOT	T	FOC.	305	254	480	480	18.5	18.5				7 H 7.70	45ec	sec			·	
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NT	CAMERA	₹S SS:	C-7	C-2	1- H	A-2	C-3	C-3				1	8	312		CAMERA 1		
<_ EVE	J	NO.	E-11	E-5	x R-3	4-4	30 GSP	110 GSP	1			ACTUAL	XR-S	R-4		DATE CA		

PHOTO LOADING CHART

WHITE TRUCK

STATION 3-358

PERF.

HOLDER

SIZE

EMULS.

TYPE

MF

FILM

FORM E-40

DATE FILM LOADED

REMARKS

EDGERTON, GERMESHAUSEN & GRIER, INC.

60795

2/4-3/4 HOLDER

16-100 H.S. REEL 60855 1 2/4-3/4 HOLDER 60794 >

BD

MF

60792

16-100 H.S. REEL

60796

16-50 U-MAG

KOC

o KOC

RD

16-50 U-MAG 60797

PHOTO PLAN 4 054 * **GZ** 836984 687378 N 836 766 E 679 706 Z 4 046 STATION TYPE TRANSPORTAINER NO. 3 STATION SISTANCE OBJECT 7675.3 # STANCE GZ 7675.1 Ft STATION NO. 3-357

7672 DIFF. 2/8

BRG 88° 22'

TILT . 6Z -0°/0′ 0.4 OBJ

EVENT HUMBOLDT

10/29/58 10/31/58 GZ STA. 73V DATE

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MARKER	N/S	4	8	4	//	//		11				: / de	delay
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×	TIME ON/OFF	-1.5/+1.5	-1.5/	-5/30)}		-5/30	-5/430				usec ha	cc hall
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	^	1,40,77	0°4′	+ 7°48′	+ 0°27	+ 0°2′	+ 7*58'	, + '0°24'			ELA	45	2 26 2
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FIRD	TARGET H/V	.225 .175	.225	3.800 2.450	.800 .800	. 800 . 800	3.195 1.960	4.485			ACTUAL	R-34	R-30
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LENS	S/N	784702	C73377 W-12	MA4481 W-12	773948	480 773953	69261	12318					
	FOC.	305		50	A-2 480	480	25	18.5					
A	RACK POS.	8-2	8-1 500	1-H	A-2	A-3	7-8	A-/					
CAMERA	NOM SPD.	E-33 2500	2500	700	40x5 CO16	R-30 4ms	64	64				·	
	NO.	£-33	1-3	M-2	R-34 4045	R-30	60 55P	128 55P			A TOTAL		

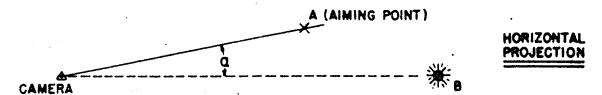
REMARKS * INCLUDES 30 FF HEIGHT OF TOWER

FINAL

FORM E-40

						PHOTO LOADING	0	PAC	SNC		CHART		,	
(1)	STAT	STATION 3-357 TRANSPORTAINER NO.3	57 TR	JNS POR	TAINER NO	EVENT	N TN	HUMBOLOT	120T			_ DATE	ľ	10/29/53
			FILM			J	CAMERA			LENS	W L	EXPOSURE	JE	
-	TYPE	EMULS. NO.	SIZE	HOLDER	PERF.	Ã.	POS.	NON SPO.	O.₹	FILTER	APER	SHUTTER RHEO.	W/M2	REMARKS
₹	MF		16-700	16-100 H.S. REEL	60802	£-33	8-2	2500	305	NO-1+ W-12	f8.0	4%	3x105	٠
*	MF		001-91	16-100 H.S. REEL	60803	1-3	1-8	2500	500	W-12	£9.3	40/80	2×104	
4	FX		35-200	MIT MAG	60850	M-2	1-H	001	50	W - 12	0.7f	170°	WESTON 400	FAST PROCESS
4	RP		2/4-3/4	2/4-3/4 RALDEDER	15809	R34	7-B	40xs Co1c	480		0111	BWB	3×105	loos 4sec delay
Ψ.	RP		2/4-3/4	RAP HOLDER	25809	R30	A-3		480	1-0N	£11.0	BULB	1.5 x 107	SOHSEC delay
	KOC		16-50	U-MAG	90809	99 989	1- H	64	25		0.7J	1/33°	WESTON 500	
्र 15-	KDC		16-50	U-MAG	50807	128 GSP	1-H	64	18.5	Ц	£5.6	/33°	WESTON 800	
								·						
		·				ACTUAL		RAP DE	SXH790					
						R-34	896	4 4	ec +	20 H Se	half.	coil de	'ay .	
						R-30	53.9	438	+ 2	4sec)	a 1 f . co.	1 delay		
								•						
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-	DATE	DATE FILM LOADED	030			DATE CA	CAMERA LOADED	OADED			٥	DATE EXP	EXPOSED	
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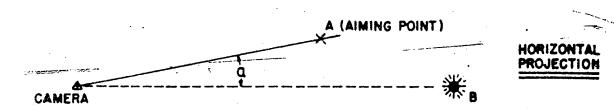
FILM NO. 60794	STATION NO. WHITE TRUCKA	TEST HUMBOLDT	CALCULATED BY:JEC
CAMERA NO. XR-3	EQ. AP.		DATE: 12/1/58



A. $R^{\circ}/A = CB_h \cos \alpha \cos$	β + (H _B - H _C) sin β	86 V 1775
G = 0°00′	β= 0°45'	H ₈ = 4054 f+
cos a = 1.00000	$\cos \beta = 0.999914$	Hc = 3997 ft
$CB_h = 2/63.9 m$	$\sin \beta = 0.0/3090$	ΔH= 57 ft = 17.4 m
CBh cos a cos $\beta = 2/63.7 m$	$\Delta H \sin \beta = 0.23 m$	R ⁰ / _A = 2/63.93 m
B FOCAL LENGTH 474	76 mm (774605)	

- MAGNIFICATION FACTOR (meters/in.) 115.29 C.
- ZERO TIME CORRECTION 0.10 msec delay D.

FILM NO. 60795	STATION NO. WHITE TRUEXA	TEST HUMBOLDT	CALCULATED BY: JE
CAMERA NO. R-4	EQ. AP.		DATE: /2/1/58



A. $R^{\circ}/A = CB_h \cos \alpha$	$\cos \beta + (H_B - H_C) \sin \beta$	
a= 0°00'	β= 0.45'	Hg= 4054 ft
cos a = /.00000	$\cos \beta = 0.999914$	Hc= 3997 ft
$CB_h = 2/63.9 m$	$\sin \beta = 0.013090$	$\Delta H = 57ft = 17.4 m$
CBh cos a cos $\beta = 2/63.7$	$7m \Delta H \sin \beta = 0.23 m$	R ⁰ / _A = 2/63.93 m
D FOCAL LENGTH		

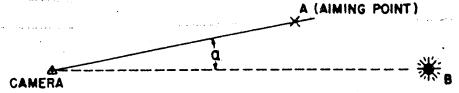
B. FOCAL LENGTH 477.82 mm (773952)

C. MAGNIFICATION FACTOR (meters/in.) 115.03

D. ZERO TIME CORRECTION 3.15 msec delay

FILM NO. 60851	STATION NO. 3-357	TEST HUMBOLDT	CALCULATED BY:JEC
CAMERA NO. R-34	EQ. AP.		DATE: /2/1/58

HORIZONTAL PROJECTION

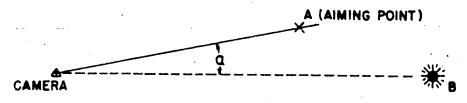


B + (HB -HC) SIN B	
β= 0°27'	HB= 4054 ft
$\cos \beta = 0.99997$	Hc= 4046 ft
$\sin \beta = 0.00785$	$\Delta H = 8ft = 2.44 m$
$\Delta H \sin \beta = 0.00 m$	R ⁰ / _A = [2339.3 m]
	$\cos \beta = 0.99997$

B. FOCAL LENGTH 479.03 mm (773948)

- C. MAGNIFICATION FACTOR (meters/in.) 124.04
- D. ZERO TIME CORRECTION 0.99 msec delay

FILM NO. 60852 STATION NO 3-357 JEST HUMBOLDT CALCULATED BY: JEC CAMERA NO. R-30 EQ. AP. DATE: 12/1/58

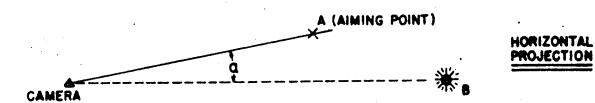


HORIZONTAL PROJECTION

A. $R^{\circ}/A = CB_h \cos \alpha$	$\cos \beta + (H_B - H_C) \sin \beta$	
a= 0°00′	β= 0°27'	H _B = 4054 ft
COS a = 1.00000	$\cos \beta = 0.99997$	Hc= 4046 ft
CBh = 2339.4 m	$\sin \beta = 0.00785$	ΔH= 8ft = 2.44 m
CB _h $\cos \alpha \cos \beta = 2339.3$	$m \mid \Delta H \sin \beta = 0.00 m$	$R^{0}/_{A} = [2339.3 m]$
B FOCAL LENGTH	170 20 00 (772052)	

- MAGNIFICATION FACTOR C. (meters/in.) 123.97
- ZERO TIME CORRECTION 0.05 msec delay D.

FILM NO. 60855	STATION NO. WHITE TRUCK MAZ	TEST HUMBOLDT	CALCULATED BY: JEC
CAMERA NO. E-5	EQ. AP.		DATE: 10/29/58

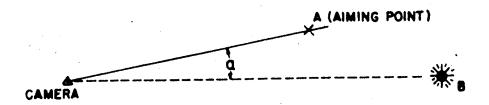


A. R%=CBh cos α cos β + (H _B -H _C) sin β				
a= 0°00'	β= 0°45'	Hg= 4054 f+		
cos a = /.00000	$\cos \beta = 0.999914$	H _C = 3997f		
CBh = 2/63.9 m	sin β = 0.0/3090	△H=57ft=17.4 m		
CBh cos a cos $\beta = 2/63.7 m$	$\Delta H \sin \beta = 0.23 m$	$R^{0}/A = 2/63.93 m$		
CON COS C COCP 27001				

B. FOCAL LENGTH 250.2 mm (8763/2)

- C. MAGNIFICATION FACTOR (meters/in.) 2/9.68
- D. ZERO TIME CORRECTION 0.16 msec

FILM NO. 60855	STATION NO. 3-358 TEST HUMBOLDT	CALCULATED BY: JEC
CAMERA NO. E-5	EQ. AP.	DATE: 10/29/58



A. $R^{\circ}/A = CB_h \cos \alpha \cos$	$\beta + (H_B - H_C) \sin \beta$	
a = 0°00′	β= 0°45'	HB= 4054 ft
COS a = /.00000	$\cos \beta = 0.999914$	H _C = 3997ff
CBh = 2/63.9 m	sin \(\beta = 0.0/3090 \)	△H=57ft=17.4 m
CBh cos a cos $\beta = 2/63.7 m$	$\Delta H \sin \beta = 0.23 m$	$R^{0}/A = 2/63.93 m$
D FOCAL LENGTH 25	a 2 mm (8763/2)	

219.68 MAGNIFICATION FACTOR (meters / in.) C.

ZERO TIME CORRECTION 0.16 msec D.

SHOT HUMBOLDT

FILM NO. 60855

						PIADKONE	HUDER
Fr. No.	Mag.	Dl	D ₂ .	D ₃	Davg (m)	Dave (m)	t (ms)
0	29.00	0111	0114		8. 53		0.16
0 1	23,00	0147	0151		11,29		0.51
2		0173	0180		13.38	·	0.85
3		0197	0200		15.05		1.20
		0214	0221		16 49 17, 55		1.55
4 5		0230	0233		18.50		1.90
6		0239	0249		19.03		2. 25
7 ,		0248	0254		19.86		2.5 9.
8		0258	0266	4	20.43		2.94
9		0268	0271		21.07		3.29
10		0276	0280		22.06	}	3.64
		0284	0282		22.51		3.99
11 12		0288	0294		22.85		4.35
/13		0294	0300				4. 68
/ 14		0298	0305				5.03
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DATE	10/2	9/58		•	•	DATE	

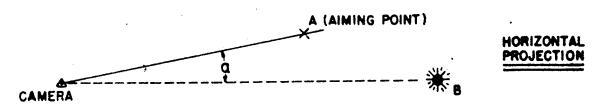
REMARKS:

FIREBALL CALCULATIONS

SHOT	HUMBOLDT	FILM NO	60855	
		DATE		
	•			

1109 51 2423.94 .673.35 - 763.832 143.838 1538 95 2593.77 162.45 - 9370.85 142.138 1505 120 2711.45 182.25 10.756.26 139.138 1649 155 2802.83 438.33 11.916.42 138.128 1755 190 2865.11 641.87 12.927.21 135.128 1850 225 2917.80 810.86 13.831.28 135.128 1903 259 2946.04 951.58 14.632.10 136.128 1996 294 299.970 107.937 15.793.33 129.333 2043 329 3016.99 1190.90 16.102.07 126.207 2107 364 3047.82 1292.04 16.760.84 129.204 2106 435 3093.71 1470.24 18.005.58 122.206 2251 468 3113.90 1547.33 18.539.81 123.206	278 291 376 3775 3775 3775 3775 3775 3775 3775

FILM NO. 60802	STATION NO. 3-357	TEST HUMBOLDT	CALCULATED BY: JEC
CAMERA NO. E-33	EQ. AP.		DATE: /2/1/58



A. $R^{\circ}/A = CB_h \cos \alpha \cos \alpha$	$\beta + (H_B - H_C) \sin \beta$	
a = 0°00′	β= 0°27'	H _B = 4054 ft
cos a = /. 00000	$\cos \beta = 0.99997$	Hc= 4046 ft
$CB_h = 2339.4 m$	$\sin \beta = 0.00785$	$\Delta H = 8 ft = 2.44 m$
CBh $\cos \alpha \cos \beta = 2339.3 m$	$\Delta H \sin \beta = 0.00 m$	$R^{0}/_{A} = 2339.3 m$
B. FOCAL LENGTH 30	6.9 mm (784702)	

C.	MAGNIFICATION	FACTOR	(meters/in.) 193.6	

D. ZERO TIME CORRECTION 0.01 msec

DIAMETER MEASUREMENTS							
SHOT_H	UMBOLD	Т			FILM NO	60802	·
%.							Ymrab
Fr. No.	Mag.	D 1	D ₂ .	D ₃	Dave (m)	PARKOWS Dave (m)	t (ms)
0 1 2 3 4 5 6 7 8 9 10	48. 15	0129 0247 0308 0211 0231 0247 0264 0279 0291 0300 0307	0131 0240 0304 0208 0228 0247 0264 0281 0291 0301 0308		5. 23 9. 79 12. 30 14. 04 15. 38 16. 55 17. 69 18. 76 19. 50 20. 13 20. 60		0. 01 0. 40 0. 78 1. 17 1. 55 1. 94 2. 33 2. 71 3. 10 3. 48 3. 87

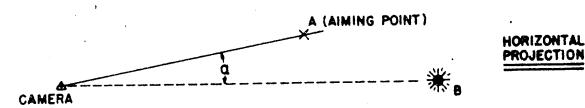
READ	BY LW	JEC	TYPED BY
DATE	10/	29/58	DATE

REMARKS:

FIREBALL CALCULATIONS

	SHOT HU	MBOLDT	FILM NO.	60802	
. D		In D	Int	† ² /5	φ.
5.23 9.79 12.30 14.04 15.55 17.69 18.75 19.50 20.60	.01 40 787 1594 1594 1293 1087 1087	1.654 39 2.281 33 2.509 55 2.641 95 2.733 14 2.806 46 2.873 0.5 2.931 75 2.970 42 3.000 20 3.000 20 3.000 27	4.60509 - 91621 - 94844 - 15693 43833 66269 84579 99688 113139 124707 135332	.1 590 64 6 931 64 9 053 99 10 647 84 11 916 42 13 035 33 14 025 88 14 899 65 15 723 27 16 467 95 17 182 93	- 32,8 79 141,23 135,85 131,85 129,06 126,96 126,12 125,90 124,01 122,23 119,88

FILM NO. 60803	STATION NO. 3-357	TEST HUMBOLOT	CALCULATED BY: JEC
CAMERA NO. E-/	EQ. AP.		DATE: /2/1/58



$ \begin{array}{c c} \text{Sin } \beta \\ \text{H}_{B} = 4054 \text{ ft} \\ \text{H}_{C} = 4046 \text{ ft} \end{array} $
H = 101/ St
$H_{C} = 4046 ft$
$\Delta H = 8 ft = 2.44 m$
$R^{0}/_{A} = 2339.4 \text{ m}$

C. M	AGNIFICATION	FACTOR	(meters/in.)	109.7	

ZERO TIME CORRECTION 0.10 msec D.

DIAMETER MEASUREMENTS

	HUMBOLDT	•	film no	60803
BHUT	HOMDODDA	•		•

ion.	a	-				PLANKON	STUDER
Pr. No.	Hag.	בַּע	D2	D ₃	Dave (m)	Dave (m)	t (ms)
0	28.90	0191	0 191		7. 26		0. 10 0. 48
1		0282	0286	1	10.79 13:05	•	0. 48
2 . 3	19.23	0228 0258	0230 026 3	: .	14.85		1. 25
. ,3	-	0278	0282		15.96 17.16		1.63
4 5		0301	0301		18. 23		2.01 2.40
6	9.66	0161	0160	•	19.08 20.05		2.78
7)	0169 0177	0167 0176	•	20.50		3.17
8 9		0182	0179				3. 5 5
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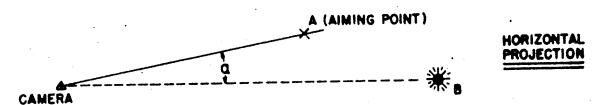
READ	BY plw rh	TYPED	BA
DATE	74.	10/29/58 DATE	

REMARKS:

FIREBALL CALCULATIONS

	SHOT HU	MBOLDT	FILM NO.	6 0803	
D	t	In D	Int	t ² /5	ф
7.26 1079 1305 1485 1728 1720 1800 1800 1800 1800 1800 1800 1800 18	.10 .48 .25 1.65 1.63 2.71 2.78 3.75	1.98234 237856 256878 256807 277016 284265 290311 290872 302040	2.302 51 - 733 94 - 150 75 - 223 10 488 65 698 12 875 39 1022 39 1153 73 1067 00	.3 981 19 7 455 90 9 41 4 80 10 933 45 12 158 73 13 221 37 14 192 90 15 052 47 15 864 40 16 599 71	18235 14471 13861 13582 13126 12978 12844 12675 12638 12349

30792	STATION NO WHITE TRUCK N	TEST HUMBOL OF	CALCULATED BY: JEC
) E-//	EQ. AP.		DATE: 12/1/58



= CBh cos a cos	$\beta + (H_B - H_C) \sin \beta$	
,	β= 0°29'	H _B = 4054 ft
00000	$\cos \beta = 0.99996$	Hc= 3997 f+
63.9 m	sin B = 0.00844	ΔH= 57ft=17.37m
	$\Delta H \sin \beta = 0.1 m$	R%= 2/63.9 m
	(204(01)	

				· · · · · · · · · · · · · · · · · · ·
AL.	LENGTH	305.9	mm	(784691)

NIFICATION	FACTOR	(meters/in.)	179.68	

O TIME CORRECTION 0.01 msec

au (vr	HUMBOLDT	
Z 54 E 71"	11011120	-

FILM NO. 60792

-			•				ONRIGUER	•
Pr. No.	Mag.	D ₁	D ₂	р3	Dave (m)	Dave (m) t (ms)	.
0	48.15	0161 0267	0161 0259	0161 0267	6, 00 9: 86		0.01 0.39	No.
1 2 3 4	28. 90	0328 0229 0253 0272	0326 0219 0245 0259	0330 0220 0241 0265	12. 23 13. 85 15. 32 16. 50		0.76 1.14 1.51 1.89	
5 6 7 8		0287 0298 0309	0276 0290 0298 0308	0277 0288 0305 0314	18.16 18.90 19.57		2. 27 2. 64 3. 02 3. 40	
9		0322	. 0500	••		-		
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REMARKS:

DATE

10/29/58

DATE

FIREBALL CALCULATIONS

SH	ют	UMBOLDT	FILM NO.	FILM NO				
	•	•	DATE					
	t	in D	Int	† ² /5	φ.			
	.01 39 76	1.79168 228844 250384	4.60509 - 94153 - .27444 -	6 861 80	37.7 20 1 4 3 6 9 1 3 6 4 9			

636 59

1 1 0 5 2 3

1.223.81

10 537 76

15 5 5 9 6 1

125 50

2 628 32

- 293918

1.51

340 -

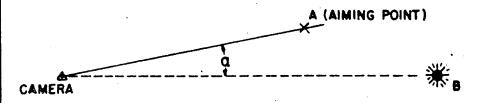
b

6.00 9.86

16 50

CAMERA DATA & CALCULATIONS

0872	STATION NO. 3-358	TEST HUMBOLDT	CALCULATED BY: JEC
FRAMING	EQ. AP.		DATE: 1/29/60



HORIZONTAL PROJECTION

: CBh cos a	cos B + (HB -HC) sin B	
0'	β= 0°29'	H _B = 4054 ft
10000	$\cos \beta = 0.99996$	H _C = 3997 ft
4.7m	$\sin \beta = 0.00844$	ΔH= 57ft = 17.37m

34.7m $\sin \beta = 0.00844$ $\Delta H = 57ff = 17.37m$ $\cos \beta = 2164.6m$ $\Delta H \sin \beta = 0.1m$ $R^{0}/_{A} = 2164.7m$

L LENGTH

IFICATION	FACTOR	(meters)	/in.)

TIME	CORRECTION	0.03	msec	1/2 fr

HUMBOLDT SHOT

FILM NO. 60872

			·			FIADXONR	INAL
Fr. No.	Mag.	D ₁	D ^S	D3	Davg (m)	Dave (m)	t (ms)
0	48.34	0092	0099	 	4.16		0. 03
1		0128	0131	,	5.72		0.09
2		0157	0161		7, 13		0.16
3		0168	0167		7.46		0.22
4		0182	0188		8. 14 8. 80		0. 28
.		0195	0201		9.41		0.34
6		0208	0214	·	9. 91		0.41
7		0222	0229		10,39	•	0.47
8	•	0233	0237		10, 85		0.53
9		0247	0248		11.19		0.59
10		0257	0257		11.73		0.66
		0264	0267		12.14		0.72
11		0274	0275		12.37		0.78
12		0274	0213		12.66		0.84
13		0211	0204		12.98 13.35		0.91
14	•	0293	0230		13. 35		0. 97
15		0173	0184		13, 55		1.03
16			0184		13 77		1.10
17		0176	0184		14.38		1, 16
18		0182	0184		14.33	Ì	1. 22
19		0186	0195		14.74		1. 28
20	÷	0195	0195		15. 11 15. 60		1.34
21	21	0198	0200		15. 55		1.41
22	•	0202	0201		15.55		1.47
2 3		0208	0208 02 13	,	16.24	.	1. 53
24		0213	0213		16.48		1.60
25		0210			16.53		1.72
26		0. 0. F					1. 78
27		0222	0218				1. 85
≒ 28		0222	0223		<u></u>		1. 00
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DATE	1/2	9/60				DATE	•

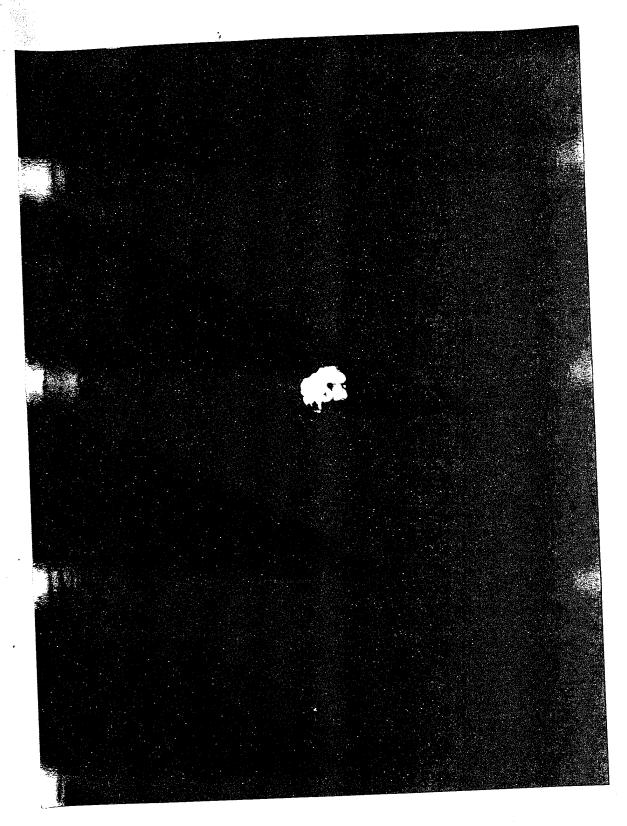
REMARKS:

0.30

FIREBALL CALCULATIONS

.*	SHOT HUN	MBOLDT	FILM NO	60872	
			DATE		
D	† ·	in D	Int	t ² /5	ф
4.173 7.144 9.038 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.0	.00128417396284173062841730285 .0128417396284173062841730285	1.74453219304853203112913354525 5907432193048532031129 1.474695481930455155695666205431 2273344695569766669054354 2277448525 2277448525 2277448525	3-21-1-1	991 45991 480463 50095045 60095045 77768 9003 9003 9003 9003 9003 9003 9003 900	149 39 10 148 135 448 133 133 133 133 133 133 133 133 133 13

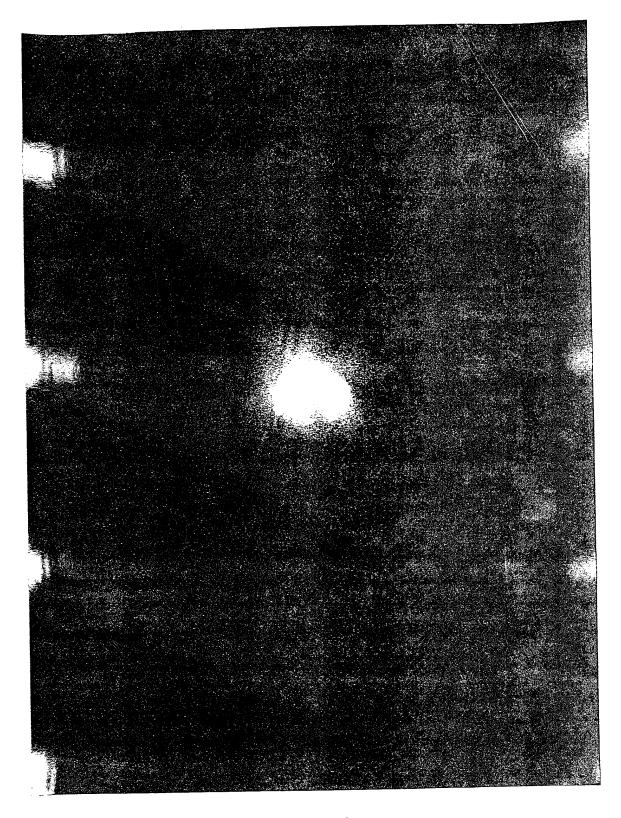
APPENDIX A HARDTACK PHASE II, HUMBOLDT PHOTOGRAPHIC EXAMPLES



Camera: Rapatronic-30

Station: 3-357

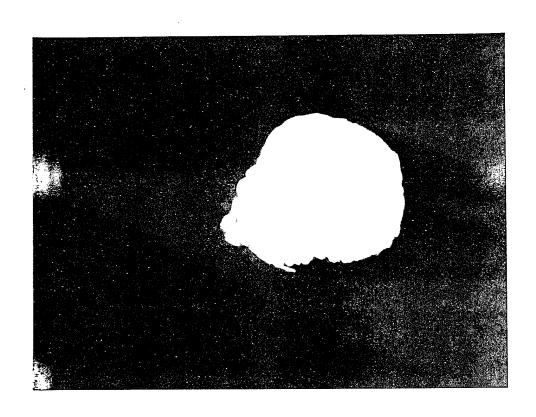
Time: 0.05 msec



Camera: XR-3

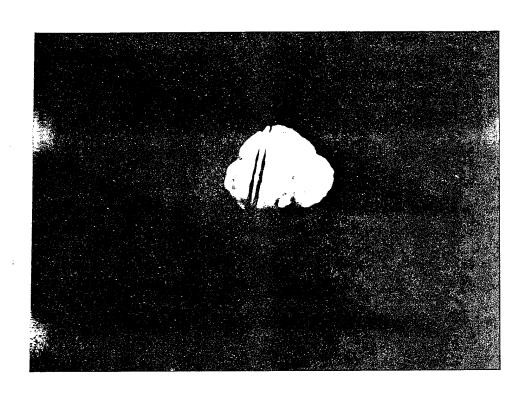
Station: 3-358

Time: 0.10 msec



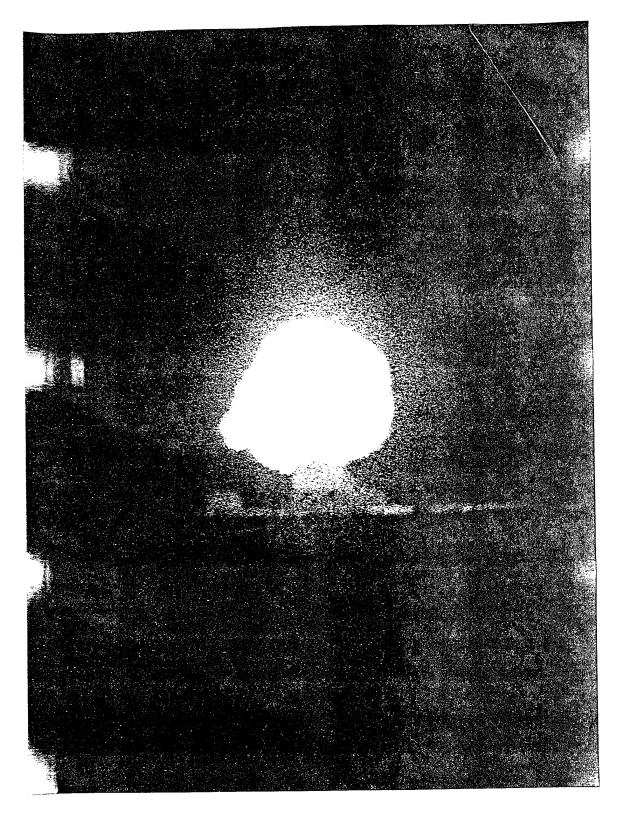
Station: 3-357

Time: 0.48



Station: 3-358 (White Truck No. 2)

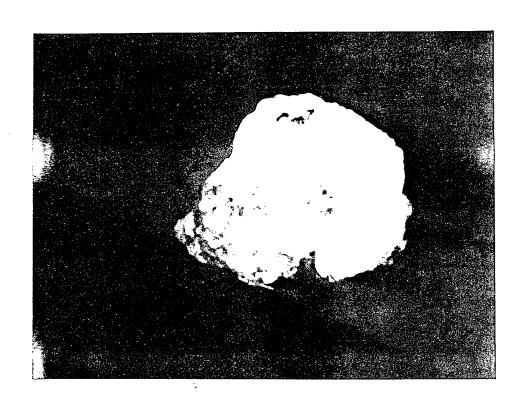
Time: 0.76 msec



Camera: Rapatronic R-34

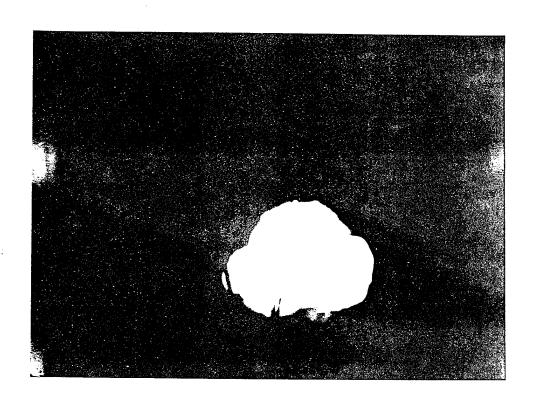
Station: 3-357

Time: 0.99 msec



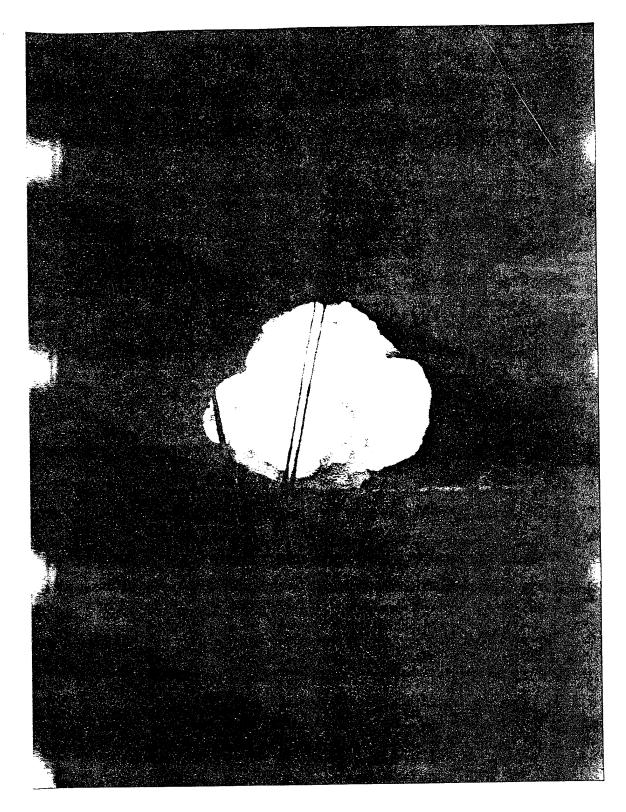
Station: 3-357

Time: 1.63 msec



Station: 3-358

Time: 2.94 msec



Camera: R-4

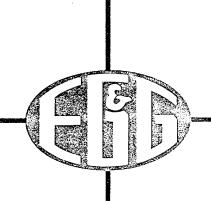
Station: 3-358

Time: 3.15 msec

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